

Enrichment materials for fattening pigs: summary of IFIP trials

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Three trials compared different objects designed to enrich the living space of fattening pigs housed on fully slatted floors. The objects were composed of chains, sometimes associated with other objects: a plastic ball or variably sized pieces of wood. They were fixed to the floor or accessible at floor level, except for one chain fixed at snout height. Twelve objects were tested, including a chain hanging 5 cm above the floor as a control in each trial. These devices enabled the study of the effects of location (height, and place in the pen), number of objects (one vs. three), and the nature of the object (organic or not). The trials were conducted in an experimental room containing 12 pens of 10 pigs in one replicate (Trial 2, four objects) or two replicates (Trial 1, four objects, and Trial 3, six objects replaced after 6 weeks). Direct observation of the pigs for 2 h 30 min was carried out several times during fattening, and their physical condition was recorded.

More than on the nature of the object, the rate of use of the objects depended on their cleanness, ease of access, whether they were deformable or destructible, their nearness to the floor, and how low their mobility was. Inorganic objects such as chains can meet most of these criteria.

Intérêt des matériaux manipulables pour les porcs à l'engraissement : bilan des travaux réalisés par l'IFIP

Trois essais comparent différents objets d'enrichissement du milieu de vie des porcs à l'engraissement logés sur caillebotis intégral. Les objets sont composés de chaînes, associées ou non à d'autres objets : boule de plastique ou morceaux de bois de taille variable. Ils sont fixés au sol ou disponibles en position basse, à l'exception d'une chaîne fixée à hauteur de groin. Douze objets sont testés, dont une chaîne placée en position basse présente comme témoin dans chaque essai. Les dispositifs permettent d'étudier les effets de la localisation (en hauteur, emplacement dans la case), du nombre d'objets (1 vs 3), de la nature de l'objet (organique ou non). Les essais sont conduits dans une salle expérimentale comportant 12 cases de 10 animaux sur une bande (Essai 2, 4 objets) ou deux bandes de porcs (essai 1, 4 objets et essai 3, 6 objets remplacés au bout de six semaines). Des observations directes des animaux sont effectuées à plusieurs reprises au cours de l'engraissement pendant 2h30 et leur état physique relevé.

Plus que de la nature de l'objet, le taux d'utilisation des objets dépend de leur propreté, de leur facilité d'accès, de leur possible déformation voire destruction, de leur positionnement à proximité du sol, d'une mobilité réduite. Des objets inorganiques comme des chaînes peuvent satisfaire la plupart de ces critères.

Keywords: enrichment, pig, slatted floor, wood, chains

Mots clés : enrichissement, porc, caillebotis, bois, chaînes

Introduction

Exploring is a major behavioural feature in pigs. A shortage of substrates on which to express this activity is one risk factor for the occurrence of cannibalism, as the pig transfers its investigative activities towards other pigs in the pen (EFSA, 2012). Regulations are designed to meet this need: the Directive 2008-120-EC stipulates that pigs “must have permanent access to a sufficient quantity of material to enable proper investigation and manipulation activities, such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such which does not compromise the health of the animals.”

Use of the loose materials proposed as examples in the above list is not possible in pig farms with slatted flooring. The materials fall through the gaps and prevent proper removal of dung. A trial carried out at the IFIP station at Romillé illustrates this incompatibility (Courboulay, 2006). A composite object fixed to the floor was compared with straw dispensed ad libitum from a rack. The straw was long-stalk, the form that allows most exploratory activity (Day et al, 2008). The straw was used more than the object, but the two treatments showed no differences for either the expression of social behaviour or the occurrence of wounding (scratches/abrasion or tail biting), suggesting a sufficient level of investigation. However, straw provided ad libitum, i.e. at about 35 g/pig/day, hindered the evacuation of manure by gravity, and required manual removal.

The most widely used type of flooring in France is slatted, accounting for 93% of fattening pig pens in 2008 (Martin-Houssart, 2010), mainly as a fully slatted floor. This option avoids the higher production costs arising from procurement and cost of straw, and its associated longer working hours and larger building surface areas (storage of straw and more surface area per pig).

Research has been in progress for several years at IFIP to seek devices that will favour pigs' investigation activities throughout the fattening phase in our slatted-floor rearing conditions: qualities of the object, positioning, and the nature of the behaviours expressed. The aim, for the objects tested, was to meet the objectives of the regulations and also to make sure their use was technically feasible. For convenient use in pig farms, the objects tested had to be durable and not need to be replaced too often. The first trials showed that for the same physical qualities, objects on the floor were more attractive than objects placed at a height, and enabled the pig to express a broader variety of activities (Courboulay, 2004).

A series of trials were conducted to validate this result and test various readily accessible devices for animals. This article presents the results of three comparative tests in which four to six objects were tested simultaneously. The synthesis of these results enabled us to rank the objects in terms of attractiveness and to propose some rules for providing pigs with efficacious enrichment materials.

Materials and methods

Pigs – housing

All the trials were set up in the same shed, which contained twelve pens each measuring 7 m². Each pen was equipped with an individual feeder and free access to water. Five groups of 120 pigs were used: two groups for Trials 1 and 3, and one for Trial 2. Each pen housed five male pigs and five female pigs from the same number of different post-weaning pens. Start of the fattening phase was age 9–10 weeks according to the trial.

Experimental treatments

All the devices tested used chains, commonly used in pig farms, sometimes associated with additional objects. The location of the objects in the pen was the same for all the objects tested (Figure 1), except for one chain placed at the end of the pen, the usual excretion area for the pigs, in the corner opposite the feeder (Trial 3, object CA). Each object was placed in position before the pigs entered the pen. The same control object, a low-placed metal chain (noted CB) was used in each trial. This low position, mentioned regularly in this article, was about 5 cm above floor level.

Trial 1

The aim of this trial was to test different ways of presenting the chains. Four objects were compared. Each object was present in three pens. Two successive groups were used.

- **High chain (CH):** high-placed metal chain set at snout height and raised regularly during fattening.
- **Low chain (CB):** low-placed metal chain.
- **Three pipes floor (3TS):** object composed of three plastic pipes of approx. 30 cm through which a chain was threaded and fixed to the floor.
- **Three chains floor (3CS):** object on the floor composed of three metal chains each fitted with a double end link to prevent the chain falling through the gaps, the other end being fixed to the floor.

This last device was a prototype tested in the earlier studies, that proved promising for use by animals and offered a low risk of tail biting (Courboulay, 2006).

Trial 2

The aim of this trial was twofold:

- 1) test the utility of an organic material, namely a wooden log, readily available on most farms.
 - 2) assess the usefulness of fixing an object at the end of the chain, the use of a chain alone being sometimes criticised.
- Four objects were compared. Each object was present in three pens.
- **Low chain (CB)**: low-placed metal chain.
 - **Chain + plastic ball (CPq)**: low-placed metal chain, at the end of which was fixed a plastic ball of diameter 7 cm, hanging at 5 cm above floor level.
 - **Log floor (RBoS)**: large wooden log fixed to the floor.
 - **Free log (RBoL)**: large wooden log free in the pen.

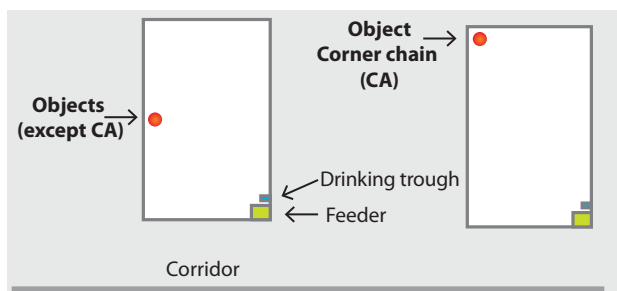


Figure 1: Positioning of objects in the pen

Trial 3

The aim of this trial was to improve the attractiveness of conventional objects, namely chains and wood:

- 1) varying the location of the chain in the pen,
- 2) comparing the provision of single objects or three objects simultaneously,
- 3) testing different designs of wood-based objects.

Six objects were compared. They were composed of a single module (chain, block of wood 16 × 7 × 7 cm) or a triple module (three chains, three blocks of wood). Each object was present in two pens. After 6 weeks, the object was replaced by a different object, but with the same number of modules. Two successive trial periods were set up, Period 1 running from the entry of the animals to 6 weeks later.

The objects tested were as follows:

- **Chain + wood (CBo)**: wooden block at the end of a low-placed chain.
- **Low chain (CB)**: low-placed metal chain.
- **Corner chain (CA)**: low-placed metal chain positioned in the corner of the pen, opposite the feeder.
- **Three wood chain (3CBo)**: three wooden blocks fixed on a chain, both ends of which were attached to a bar fixed to the pen partition.
- **Three wood floor (3BoS)**: Three wooden blocks fixed to the floor.
- **Three low chains (3CB)**: three low-placed metal chains.

In this trial, the 3CBo object, composed of wooden blocks fixed to the same chain, was slightly changed at the start of the second observation period of the first group, in response to tail biting seen in the two pens concerned. One link of the chain was removed. The final object was composed of one wooden block on one chain, and two on the other, one of which laying on the floor (Photo 1). Two groups were used.



Photo 1: Final condition of the object "3 wood chain" of Trial 3 after modification

Measurements

Four to six animal behavioural observations were performed at regular intervals during fattening period according to the group (respectively 5, 6, 4, 6 and 6 for groups 1–5). In Trial 3, three series of observations were made per period. The behaviour of each pig was recorded every 10 minutes for a period of 2 h 30 min at the end of the afternoon. The behaviours recorded were feeding or drinking behaviours, social behaviours, investigation behaviours directed towards the objects or other parts of the pen, resting, and other behaviours. Table 1 gives a detailed ethogram.

Lesions and wounds were scored during the behaviour scoring week (Trials 1 and 2) and twice per period for Trial 3. They were qualified using the Welfare Quality scale (Welfare Quality®, 2009). The two sides of the animal were scored, and two scores were calculated: an overall score (lesions and wounds) and a scratch score (lesions) that was more specific for aggressive interactions.

Tail and ear status was scored as follows:

- **0**: No bites,
- **1**: Superficial bites,
- **2**: Large wound or tail/ear torn.

Table 1: Ethogram used in behavioural observations

	Description
Behaviour	
Feeding	Drinking, eating
Resting	Lying down inactive, awake or asleep
Investigation directed towards the pen	Contacts(1) snout / wall-floor-equipment
Investigation directed towards object	Contacts(1) snout / object
Social behaviour	Positive contacts: sniffing, licking, moving part of the body Negative contacts: nibbling, biting, butting, fighting
Others	Mouthing, locomotion, play, other behaviours
Postures	
Standing	
Sitting	
Lying	

¹: Nature of contacts: chewing, lifting, pushing, biting, shaking, pulling, licking, sniffing the object, gripping it in its jaws. Eying an object was also taken into account as the event preceding or accompanying a phase of manipulation

Lameness was noted after the pig had walked for some time.

The pig was scored as follows:

- 0: Normal gait or some difficulties, but all four limbs used,
- 1: Unsteady gait,
- 2: Foot not used, or inability to walk.

In Trial 1, the pigs in the first group were scored individually, but the information was not individualised. For these pigs, only the overall score was recorded, and the scoring of ear status was integrated into the overall score.

Data analysis

Data were analysed per trial. The experimental unit was the pen for behaviour and the individual for lesions. The variables describing the pigs' behaviours were expressed as a percentage of all the observations made per pen.

The postures were analysed for all the behaviours concerning the use of the objects. When required, the variables were converted into logarithms if the distribution was not normal.

The behaviour and postural data were processed by analysis of variance with repeated measures per pen (Mixed procedure, SAS). The fixed effects were the object, the week and the interaction between the object and the week, and the group was the random effect. In Trial 3, a period effect was taken into account. The interaction was then removed from the model if it was non-significant.

The lesion scores were analysed using the same model as for Trial 1; for Trials 2 and 3, repeated measures per

animal were taken into account. Pen and group were taken as random effects.

Tail, ear and lameness scores were grouped into two categories: benign or no problem (0 and 1), and severe injury (2 for ears and tail, 2 and 3 for lameness). The analysis concerns the maximum value obtained for a pig in all the observations (or per period for Trial 3). In the case of a single group, the data were analysed using a Fisher test. When there were two groups (Trial 3), a Mantel-Haenszel chi-square test was used. For Trial 1, the analysis was carried out per group; for the first group, the test concerned the distribution of problems (benign/severe) over all the scores. The second group was analysed as in Trials 2 and 3.

Results - Discussion

Behaviour of pigs

The presence of an object in the pen impacted on all the pig's investigation behaviours, whether directed towards objects, other structures of the pen or fellow pigs (Table 2). On the other hand, the objects used in these trials had no effect on feeding or other behaviours. Resting time differed among trials, ranging from 35% to 50% of the observation time, but these differences were small among treatments for a given trial (Table 2). The lowest values were observed in Trial 3. It may be possible that the change of object after 6 weeks was responsible for this result. In general, the pigs' interest in the object falls off in time (Wood Gush and Verstergaard, 1991), more or less markedly according to the type of object used (Van de Weerd et al, 2003). Providing

Table 2: Frequency of occurrence of main behaviours according to objects provided ⁽¹⁾

		Nature of behaviour					
		Towards object	Towards pen	Social	Feeding	Resting	Other
Trial 1	High chain (CH)	5.8 a ± 0.7	15.0 bc ± 0.9	10.6 ab ± 0.8	12.5 ± 0.6	46.8 b ± 2.1	9.3 ± 0.6
	Low chain (CB)	9.4 b ± 0.7	16.2 c ± 1.1	9.6 ab ± 0.7	13.2 ± 0.5	43.6 ab ± 1.8	8.1 ± 0.6
	Three pipes floor (3TS)	15.0 c ± 0.9	13.4 ab ± 0.9	8.9 a ± 0.5	12.5 ± 0.4	40.9 a ± 2.1	9.3 ± 0.6
	Three chains floor (3CS)	13.4 c ± 0.9	11.5 a ± 0.7	10.9 b ± 0.8	12.7 ± 0.5	41.4 ab ± 1.8	10.1 ± 0.7
Trial 2	Low chain (CB)	8.2 g ± 1.0	11.5 g ± 0.8	13.0 f ± 1.1	13.8 ± 0.8	44.0 fg ± 1.6	9.5 ± 0.8
	Chain + plastic ball (CPq)	8.6 g ± 0.8	12.6 g ± 1.2	12.9 f ± 1.0	13.5 ± 0.5	43.0 f ± 2.0	9.4 ± 1.1
	Log floor (RBoS)	15.2 h ± 1.3	9.0 f ± 0.7	8.9 g ± 0.5	14.6 ± 1.0	43.3 f ± 2.9	9.0 ± 1.2
	Free log (RBoL)	2.5 f ± 0.9	10.8 fg ± 0.9	11.7 f ± 1.2	14.1 ± 0.8	49.5 g ± 2.3	11.3 ± 1.0
Trial 3	Chain + wood (CBo)	9.8 xy ± 0.6	14.4 y ± 1.6	15.3 xy ± 0.8	14.7 ± 0.6	35.3 ± 2.1	10.5 ± 0.9
	Low chain (CB)	10.8 y ± 0.8	12.9 y ± 0.9	13.6 xy ± 0.7	14.3 ± 0.5	39.5 ± 1.9	8.8 ± 0.7
	Corner chain (CA)	6.8 x ± 0.7	12.8 y ± 0.9	15.6 y ± 0.9	13.6 ± 0.5	41.9 ± 2.2	9.3 ± 0.5
	3 wood chain (3CBo)	12.8 y ± 1.5	11.9 xy ± 0.7	13.6 xy ± 0.6	13.6 ± 0.6	39.1 ± 1.8	9.1 ± 0.6
	3 wood floor (3BoS)	18.9 z ± 1.2	9.5 x ± 0.7	12.4 x ± 0.8	13.8 ± 0.5	36.4 ± 1.5	9.1 ± 0.7
	3 low chains (3CB)	13.8 yz ± 0.8	11.2 xy ± 0.7	14.2 xy ± 0.7	13.9 ± 0.5	38.4 ± 1.6	8.5 ± 0.7
Statistics ⁽²⁾	Trial 1	O*	O*** S*	O* S***	S***	O* S***	S**
	Trial 2	O***	O** S**	O**	NS	O** S**	NS
	Trial 3	O*** S***	O** P*** S**	O* S**	P* S***	P* S***	S**

¹ The values indicated are means and standard deviations

² Analysis of variance with repeated measures per pen for each trial with the object (O), week (S) and O × S interaction, plus period (P) for Trial 3 as fixed effects, and the group as random effect. Only the significant effects are indicated. *: p < 0.05, **: p < 0.01, ***: p < 0.001. Means differ significantly within trials with a threshold of 5% when superscript letters are different (a-c for Trial 1, f- g for Trial 2, and x- z for Trial 3)

a new object may have prompted renewed general activity of the pigs.

The presence of an object in the pen increases the general activity of pigs (Beattie et al, 2000, Courboulay, 2004). However, this level of activity differs according to the attractiveness of the objects. For Trials 1 and 2, the objects least often used (snout-level chain, free wooden log) generated significantly less general activity than that observed in pens containing the most attractive objects. The other investigation activities did not then compensate for this activity deficit.

The pigs showed marked preferences for certain objects over others. The three trials enabled us to explore different aspects of their attractiveness.

The pigs prefer materials located on the floor to those placed high (Van de Weerd et al, 2006). Trial 1 shows that the pigs significantly preferred the chain hanging down to the floor over the one placed high. This positioning lets the pig manipulate the object when lying down. More generally, the observations in all three trials show that the most attractive objects were in general manipulated in this position (Table 3). The lying position thus seems to be a preferred posture for the manipulation of objects, as underlined by Courboulay (2004) with objects made of plastic strips. Sitting postures are infrequent among pigs. In our trials, they concerned objects placed low, not fixed to the floor, and the chain placed high. The standing posture was not associated with any specific type of object: in Trials 1–3, it was most frequent respectively with the chain placed high, the plastic ball placed low, and the object made up of wooden items distributed along a chain, part of which touched the floor.

On the floor, chains alone or associated with plastic pipes were used in similar ways (Trial 1). The presence of a destructible material did not therefore increase the manipulation of chains. These objects were more often used than chains placed low or high. This finding likely depends on a combined effect of position and number of objects, neither of which can be said to predominate. The comparison of the effect of one or three chains (Trial 3) showed an increase in the frequency of use when the pigs had three chains (13.8% vs. 10.8% of the observations, $p > 0.05$). Besides its height, the location of the object in the pen influenced how it was used. In Trial 3, the chain placed in the corner of the pen, in the excretion area, was less often used than the one located in the resting area (6.8% vs. 10.8% of the observations, $p < 0.05$). There are two hypothetical explanations for this result: (i) the corner position reduced the accessibility of the chain, which may have restricted its use, and (ii) pigs tend to differentiate their areas of activity (Stolba and Wood Gush, 1989), and

so may have used the chain less because it was located in the area reserved for excretion.

The composition of the object was not a determinant factor of attractiveness. At the same location (placed low), a chain was just as attractive alone as when linked to an object, whether inorganic such as a plastic ball (Trial 2: 8.2% vs. 8.6% of the observations, $p > 0.05$) or organic such as a piece of wood (Trial 3: 10.8% vs. 9.8% of the observations, $p > 0.05$). Furthermore, the same organic object (wooden log) could be either one of the most attractive objects or the one least used (Trial 2) according to whether it was fixed to the floor or not.

Increasing the number of objects in the pen did not increase proportionally the time the pigs spent manipulating them. Whether with chains or pieces of wood attached to a chain in a low position, going from one to three objects barely increased their use ($p > 0.05$). A similar result was found with high-placed pipes by Scott et al (2006).

Besides its position near the floor, the mobility of the object proved important. In all the tests, the objects fixed to the floor were those most often used. They could be easily lifted and moved, but within an area limited by the length of the chain they were fixed to. If the pig dropped them, they could be readily retrieved, so favouring greater use.

Their appeal was enhanced if they were destructible: the objects most often used were wood-based, of variable size and fixed to the floor (respectively 15.2% and 18.9% of the observations for the wooden log, RBoS, in Trial 2 and the three pieces of wood, 3BoS, in Trial 3). Comparatively, the pieces of wood fixed at different heights on chains were less often used: they were more difficult to grasp and hold. Observations of the condition of these objects after the trial illustrate this finding: of the three pieces of wood making up these objects (3CBo), the one on the floor was the most degraded (photo 1). Finally, the most mobile object in the pen, i.e. the free wooden log, was also the least used, as its mobility caused it to become quickly soiled.

Social behaviour and condition of pigs

The frequencies of investigation behaviours directed towards fellow pigs or other structures in the pen evolved inversely to behaviours directed towards the objects. This trend argues in favour of providing animals with attractive objects to limit the transfer of activity towards the other pigs. These transfers of activity are not translated into greater aggression among the pigs. The scores for lesions were not different between treatments (Table 4). The risk associated with the transfer of activity is mainly tail or ear biting (Van de Weerd et al., 2005).

Table 3: Postures taken during use of objects
(% scans)

		Lying	Standing	Sitting
Trial 1	CH	5.1 a ± 1.9	41.9 c ± 1.9	52.9 c ± 5.4
	CB	49.4 b ± 2.7	27.1 ab ± 2.7	23.4 b ± 2.4
	3TS	62.8 c ± 2.9	35.0 bc ± 2.9	2.2a ± 0.7
	3CS	75.7 d ± 1.8	21.8 a ± 1.7	2.6 a ± 0.7
Trial 2	CB	27.8 f ± 4.3	32.6 f ± 5.3	39.5 g ± 7.5
	CPq	21.6 f ± 5.7	56.7 g ± 6.9	21.7 fg ± 4.3
	RBoS	59.0 g ± 4.4	33.4 f ± 5.3	7.5 f ± 4.4
	RBoL	34.4 fg ± 12.7	47.8 fg ± 9.7	17.9 fg ± 5.5
Trial 3	CBo	45.7 xy ± 2.8	37.0 yz ± 2.7	17.3 y ± 2.2
	CB	53.9 xz ± 3.9	24.0 y ± 2.7	22.0 y ± 3.2
	CA	62.4 yz ± 5.1	27.7 xyz ± 4.7	9.8 x ± 2.0
	3CBo	39.7 x ± 3.9	39.4 z ± 4.3	20.9 y ± 3.3
	3BoS	64.2 z ± 2.0	30.4 xyz ± 2.2	5.2 x ± 0.9
	3CB	59.4 yz ± 3.1	18.9 x ± 1.3	21.7 y ± 2.7
Statistics ⁽²⁾	T1	O*** S*** OxS**	O*** S*	O*** S*
	T2	O**	O* S**	O*
	T3	O***	O***	O*** P*

¹ The values indicated are means and standard deviations

² Analysis of variance with repeated measures per pen for each trial with the object (O), week (S) and O × S interaction, plus period (P) for Trial 3 as fixed effects, and the group as variable effect. Only the significant effects are indicated. *: p < 0.05, **: p < 0.01, ***: p < 0.001. Means differ significantly within trials with a threshold of 5% when superscript letters are different (a-c for Trial 1, f- g for Trial 2, and x- z for Trial 3)

The frequencies of severe lesions to tail or ears ranged widely among trials and among groups, including for the control object. This finding illustrates the multifactorial character of cannibalism in pig rearing, providing the pigs with objects being only one factor to be taken into account.

Trial 3 presented the greatest number of bitten pigs (Table 4). During the first period, the pigs concerned had either a chain in the corner of the pen, or pieces of wood linked by a chain. The lower attractiveness and poorer accessibility of the chain, and a bad design of the object with the wooden items may explain this result. During the second part of the fattening phase, these pigs received another object, but this did not redress the situation. The result was a high frequency of pigs with severe lesions for the “chain wood (CBo)” and “three wood floor (3BoS)” objects in the second period, which was independent of the nature of the object present at this stage (Table 4).

During the second period, the same objects failed to stop tail biting, despite a modification to the object composed of three wooden items on a chain. The new cases of biting observed with these objects involved pigs that previously had more attractive objects, including the object made up of wooden items on the floor. This result was also reported by Courboulay and Thuard (2008) when the object was changed between the post-weaning and fattening stages. An unsuitable location of the object, a design problem or a sequence of objects with different attractiveness are factors liable to disturb investigation activities, cause frustration and favour tail biting.

The positioning of objects had no impact on the pigs' stand: few cases of lameness were recorded, whether or not objects were fixed to the floor.

Conclusion: designing objects for pigs

The overall conclusion drawn from these trials shows that objects of widely different types such as series of chains placed low or pieces of wood fixed to the floor can prompt similar frequencies of use. The low-placed chain was kept as control during all three trials. Its rate of use was similar in all the trials, which tends to validate the methodology adopted for monitoring the pigs' behaviour. We calculated a relative rate of use for the different objects relative to this control, which enabled us to rank the objects for the enhancement they provided (Figure 2).

This ranking shows that the nature of the object does not determine its actual use by the pigs, as a wooden log can be either the most or the least used object. It shows the main

Table 4: Mean scores for lesions⁽¹⁾ and frequency of severe lesion of tail or ear and lameness according to objects provided

		Scratches ⁽²⁾	Scratches and wounds ⁽²⁾	Tail lesions ⁽³⁾ , % pigs		Ear lesions ⁽³⁾ , % pigs		Lameness ⁽³⁾ , % pigs							
Trial 1	CH		19.9 ± 1.7	Group 1	2.5	Group 2	0 a	Group 1	-	Group 2	13.3 ab	Group 1	0	Group 2	6.7
	CB		20.7 ± 1.2		0		23.3 b		-		23.3 b		0		6.7
	3TS		19.6 ± 1.0	0	3.3 a	-	3.7 ab	0	0						
	3CS		19.7 ± 1.4	0	6.7 ab	-	0 a	0	3.3						
Trial 2	CB	14.9 ± 0.7	16.7 ± 0.8	0		3.3		0							
	CPq	14.8 ± 0.8	15.7 ± 0.9	0		0		3.3							
	RBoS	14.0 ± 0.8	15.4 ± 0.9	0		0		3.3							
	RBoL	15.0 ± 0.9	17.8 ± 1.3	0		0		0							
Trial 3	CBo	18.4 ± 11.6	24.0 ± 17.2	Period 1	2.5 ab	Period 2	15.8 c	Period 1	0	Period 2	0	Period 1	2.5	Period 2	5.3
	CB	18.4 ± 11.9	22.3 ± 14.8		0 a		0 a		2.5		0		2.5		2.5
	CA	19.6 ± 11.8	25.3 ± 16.9	10 b	25.0 c	5.0	5.0	2.5	0						
	3CBo	18.4 ± 10.1	22.1 ± 13.3	27.5 c	15.0 c	5.0	0	0	5.0						
	3BoS	19.2 ± 10.3	23.5 ± 13.6	0 a	12.8 bc	2.5	0	0	0						
	3CB	18.9 ± 10.1	24.1 ± 14.2	5 ab	2.7 ab	2.5	2.7	0	2.7						
Statistics ⁽²⁾	T1		S ^{***}	NS	O ^{**}	-	O [*]	NS	NS						
	T2	S [*]	S ^{***}	NS		NS		NS							
	T3	NS	NS	O ^{***}	O ^{**}	NS	NS	NS	NS						

¹ The values indicated are means and standard deviations

² Analysis of variance with repeated measures per pen for each trial with the object (O), week (S) and O × S interaction, plus period (P) for Trial 3 as fixed effects, and the group as random effect. Only the significant effects are indicated. *: p < 0.05, **: p < 0.01, ***: p < 0.001. Means differ significantly within trials with a threshold of 5% when superscript letters are different (a-c for Trial 1, f- g for Trial 2, and x- z for Trial 3)

³ Analysis of the object effect: exact Fisher test (groups 1 and 2) or Mantel-Haenszel chi-squared analysis. The numbers of pigs per treatment were 30 per group in Trials 1 and 2, and 40 per period in Trial 3

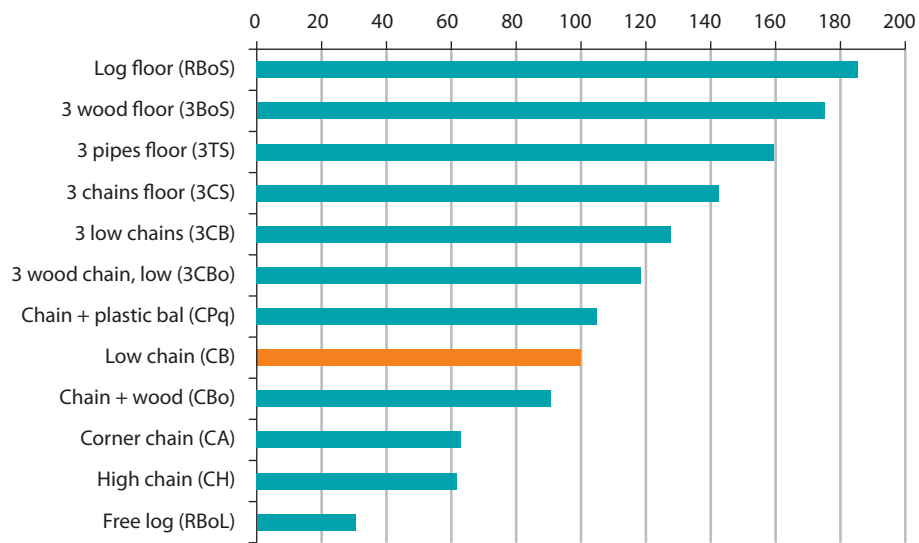


Figure 2: Ranking of objects in order of their use by pigs (relative to object "low chain")

points that must be borne in mind when designing objects to favour investigation activities:

- They must not get soiled by the pigs,
- They must be readily accessible,
- They must be deformable,
- The most attractive objects are placed on or near the floor,
- They must not be too mobile, so that they can be readily grasped and manipulated,
- Appeal is greater if the object is destructible.

Our findings show that attractive objects can be designed. These experiments conducted with objects based on chains and wood could be repeated with other materials.

On the other hand, they emphasise that the attractiveness of an object is no guarantee that it will be actually used by the pigs: a risk of tail or ear biting remains present.

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